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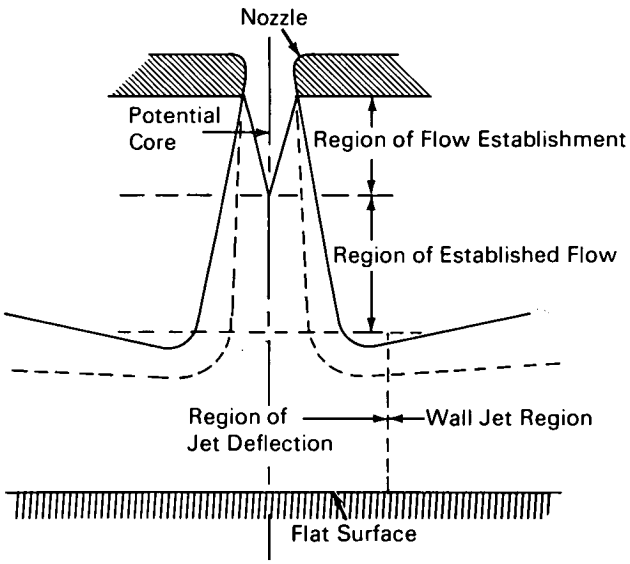
NASA TECH BRIEF

Flow Characteristics of an Air Jet Impinging on a Flat Surface

The convective heat transfer rates that can be achieved with air jets impinging at right angles on a heat transfer surface are an order of magnitude higher than those normally obtained by conventional flat plate or channel type parallel flows. Because of these heat transfer rates, the concept of using the high velocity air jets to heat or cool a surface has significant engineering potential.



Characteristic Regions in Impinging Jet Flow

Although numerous studies have been conducted on the impingement of air jets on flat plates, heat transfer results differ so widely that no adequate heat transfer correlation is available for design use. In order to develop adequate heat transfer correlations, a detailed knowledge of the jet flow characteristics is required.

The survey conducted concerned various previous investigations on the flow characteristics of a single jet impinging on a flat surface. The results are presented in Reference 1.

The flow field consists of four distinct regions (see fig.). The potential core is the center portion of the jet flow in which the velocity remains constant and equal to the velocity at the nozzle exit. Methods for predicting the spread of the jet and the velocity and pressure profiles in the various regions are described in Reference 1. Comparisons between theoretical and experimental velocity distribution data are included, as are experimental data for velocity fluctuations due to turbulence. Some suggested velocities upon which to base heat transfer correlations for use in impingement cooling designs are also discussed.

The results of further experimental investigation of jet flow characteristics are presented in Reference 2. The flow characteristics studies included: potential core length; velocity and pressure distribution through the jet; and spread of the jet and velocity decay along the jet axis.

Notes:

1. Results obtained for single jets impinging on flat surfaces should be useful for more complicated flows and geometries, such as multiple jets impinging on either flat or curved surfaces.
2. The investigations described were carried out because of an interest in the use of air jets impinging on the internal surfaces of turbine vanes and blades for the purpose of cooling such surfaces. Other applications for impinging jets include: heated jets in aircraft, for anti-icing of wings and windshield surfaces; air jets, for industrial drying of large surfaces such as paper, plastics, textiles and ceramic products; impingement cooling, for annealing nonferrous sheet metals and for tempering glass; hot gas jets, for accelerating the drying of photographic

(continued overleaf)

films after conventional bath development; and "spot" cooling of miniature electronic components.

3. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.65)

   References:

   1. NASA-TN-D-5652 (N70-18963), Survey of Literature of Flow Characteristics of Submerged Incompressible Turbulent Jets Impinging on a Flat Plate

   2. NASA-TN-D-5690 (N70-20567), Experimental Flow Characteristics of Submerged Incompressible Turbulent Jets Impinging on a Flat Plate

4. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B70-10670

Patent status:

No patent action is contemplated by NASA.

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